

FIG. 2

BEST AVAILABLE COPY

WHAT IS CLAIMED IS:

1. A thin-film magnetic head comprising first and second magnetic pole groups, magnetically connected to each other, having respective magnetic pole parts  
5 opposing each other on a side of a medium-opposing surface opposing a recording medium; a recording gap layer formed between the magnetic pole parts; a thin-film coil insulated from the first and second magnetic pole groups and helically wound about at least one of  
10 the first and second magnetic pole groups; and a substrate having the first and second magnetic pole groups, recording gap layer, and thin-film coil laminated thereon;

the thin-film coil comprising a first conductor  
15 group having a plurality of inner conductor parts disposed between the first and second magnetic pole groups, a second conductor group having a plurality of outer conductor parts disposed outside the second magnetic pole group, and a connecting part group having  
20 a plurality of connecting parts for connecting the inner conductor parts to the outer conductor parts;

the first conductor group including an insulating contact structure for making the inner conductor parts in contact with each other by way of an insulating film,  
25 the second conductor group including an insulating contact structure for making the outer conductor parts

in contact with each other by way of an insulating film.

2. A thin-film magnetic head according to claim 1, wherein any of the inner conductor parts is in contact with the first magnetic pole group by way of an insulating film.

3. A thin-film magnetic head according to claim 1, wherein the first and second conductor groups have an arrangement density of the inner conductor parts and outer conductor parts in a direction intersecting the medium-opposing surface increasing from outside the second magnetic pole group toward the second magnetic pole group.

4. A thin-film magnetic head according to claim 3, wherein each connecting part is arranged along the medium-opposing surface on the outside of the second magnetic pole group.

5. A thin-film magnetic head according to claim 4, wherein the connecting parts are disposed at respective positions distanced from the medium-opposing surface differently from each other.

6. A thin-film magnetic head according to claim 1, wherein each of the inner and outer conductor parts has a variable width structure with a path width gradually expanding from a part corresponding to the second magnetic pole group to the outside thereof.

7. A thin-film magnetic head according to

## BEST AVAILABLE COPY

claim 6, wherein the first magnetic pole group has a projection protruding toward the medium-opposing surface.

5           8.    A thin-film magnetic head according to claim 7, wherein each of the inner and outer conductor parts includes a narrowest part having the narrowest path width at a position corresponding to the projection.

10           9.    A thin-film magnetic head according to claim 7, wherein the projection has a curved surface protruding toward the medium-opposing surface.

15           10.   A thin-film magnetic head according to claim 9, wherein each of the inner and outer conductor parts is curved in conformity to a side face form of the projection.

            11.   A thin-film magnetic head according to claim 1, wherein the insulating film disposed between the inner or outer conductor parts is formed by a laminate of a plurality of alumina films.

20           12.   A thin-film magnetic head according to claim 1, wherein the second magnetic pole group is formed by a laminate of two flat magnetic pole layers.

25           13.   A method of manufacturing a thin-film magnetic head by laminating on a substrate first and second magnetic pole groups, magnetically connected to each other, having respective magnetic pole parts

## BEST AVAILABLE COPY

opposing each other on a side of a medium-opposing surface opposing a recording medium; a recording gap layer formed between the magnetic pole parts; and a thin-film coil insulated from the first and second magnetic pole groups and helically wound about at least one of the first and second magnetic pole groups; the method comprising the steps of:

forming a plurality of first inner conductor parts and a lower connecting layer both in contact by way of an insulating film with a first magnetic pole layer disposed on the substrate, and a second magnetic pole layer disposed at a position defining a yoke length;

forming an inner groove covered with a separation insulating film between the second magnetic pole layer and the first inner conductor parts adjacent each other;

forming a second inner conductor part within each inner groove, and constructing a first conductor group by the first and second inner conductor parts;

forming the first magnetic pole group by laminating a third magnetic pole layer on the second magnetic pole layer;

forming the second magnetic pole group on the first magnetic pole group so as to provide the recording gap layer;

## BEST AVAILABLE COPY

forming a plurality of first outer conductor parts in contact with the second magnetic pole group by way of an insulating film, and an insulating part disposed at a position defining the yoke length;

5           forming an outer groove covered with a separation insulating film between the insulating part and the first outer conductor parts adjacent each other;

          forming a second outer conductor part within each outer groove, and constructing a second conductor group by the first and second outer conductor parts; and

10           forming a connecting part group by placing an upper connecting layer onto the lower connecting layer, and constructing the thin-film coil by the connecting part group and the first and second conductor groups.

15           14. A method of manufacturing a thin-film magnetic head according to claim 13, wherein each of the first and second inner conductor parts and the first and second outer conductor parts is formed by plating.

20           15. A method of manufacturing a thin-film magnetic head according to claim 13, wherein each of the second inner and outer conductor parts is constructed by forming an electrode film by sputtering and then disposing an electrically conductive layer by

25           plating thereon.

          16. A method of manufacturing a thin-film

magnetic head according to claim 13, wherein the separation insulating film is formed by laminating a plurality of alumina films.

5           17. A method of manufacturing a thin-film magnetic head by laminating on a substrate first and second magnetic pole groups, magnetically connected to each other, having respective magnetic pole parts opposing each other on a side of a medium-opposing surface opposing a recording medium; a recording gap  
10       layer formed between the magnetic pole parts; and a thin-film coil insulated from the first and second magnetic pole groups and helically wound about at least one of the first and second magnetic pole groups; the method comprising the steps of:

15           forming a plurality of first inner conductor parts and a lower connecting layer both in contact by way of an insulating film with a first magnetic pole layer disposed on the substrate, and a second magnetic pole layer disposed at a position defining a yoke  
20       length;

          forming an inner groove covered with a separation insulating film between the second magnetic pole layer and the first inner conductor parts adjacent each other;

25           forming a second inner conductor part within each inner groove, and constructing a first conductor group

by the first and second inner conductor parts;

forming the first magnetic pole group by laminating a third magnetic pole layer on the second magnetic pole layer;

5 forming the second magnetic pole group on the first magnetic pole group so as to provide the recording gap layer;

forming a plurality of first outer conductor parts in contact with the second magnetic pole group by way of an insulating film;

10 providing a surface of each first outer conductor part with a separation insulating film for each outer conductor part, and forming an outer groove covered with the separation insulating film between the first outer conductor parts adjacent each other;

15 forming an electrically conductive layer in an area for arranging the thin-film coil so as to fill the outer groove;

forming a second outer conductor part in contact by way of the separation insulating film with each first outer conductor part by the electrically conductive layer, and constructing a second conductor group by the first and second outer conductor parts; and

25 forming a connecting part group by placing an upper connecting layer onto the lower connecting layer,

and constructing the thin-film coil by the connecting part group and the first and second conductor groups.

18. A method of manufacturing a thin-film magnetic head according to claim 17, wherein each of the second inner and outer conductor parts is constructed by forming an electrode film by sputtering and then disposing an electrically conductive layer by plating thereon.

19. A method of manufacturing a thin-film magnetic head according to claim 17, wherein the separation insulating film is formed by laminating a plurality of alumina films.

20. A head gimbal assembly comprising a support, a thin-film magnetic head formed on the support, and a gimbal for securing the support;

the thin-film magnetic head comprising first and second magnetic pole groups, magnetically connected to each other, having respective magnetic pole parts opposing each other on a side of a medium-opposing surface opposing a recording medium; a recording gap layer formed between the magnetic pole parts; a thin-film coil insulated from the first and second magnetic pole groups and helically wound about at least one of the first and second magnetic pole groups; and a substrate having the first and second magnetic pole groups, recording gap layer, and thin-film coil



laminated thereon;

the thin-film coil comprising a first conductor group having a plurality of inner conductor parts disposed between the first and second magnetic pole groups, a second conductor group having a plurality of outer conductor parts disposed outside the second magnetic pole group, and a connecting part group having a plurality of connecting parts for connecting the inner conductor parts to the outer conductor parts;

the first conductor group including an insulating contact structure for making the inner conductor parts in contact with each other by way of an insulating film, the second conductor group including an insulating contact structure for making the outer conductor parts in contact with each other by way of an insulating film.

21. A hard disk drive comprising a head gimbal assembly including a thin-film magnetic head, and a recording medium opposing the thin-film magnetic head;

the thin-film magnetic head comprising first and second magnetic pole groups, magnetically connected to each other, having respective magnetic pole parts opposing each other on a side of a medium-opposing surface opposing the recording medium; a recording gap layer formed between the magnetic pole parts; a thin-film coil insulated from the first and second magnetic pole groups and helically wound about at least one of

the first and second magnetic pole groups; and a substrate having the first and second magnetic pole groups, recording gap layer, and thin-film coil laminated thereon;

5           the thin-film coil comprising a first conductor group having a plurality of inner conductor parts disposed between the first and second magnetic pole groups, a second conductor group having a plurality of outer conductor parts disposed outside the second magnetic pole group, and a connecting part group having  
10           a plurality of connecting parts for connecting the inner conductor parts to the outer conductor parts;

          the first conductor group including an insulating contact structure for making the inner conductor parts  
15           in contact with each other by way of an insulating film; the second conductor group including an insulating contact structure for making the outer conductor parts in contact with each other by way of an insulating film.

20